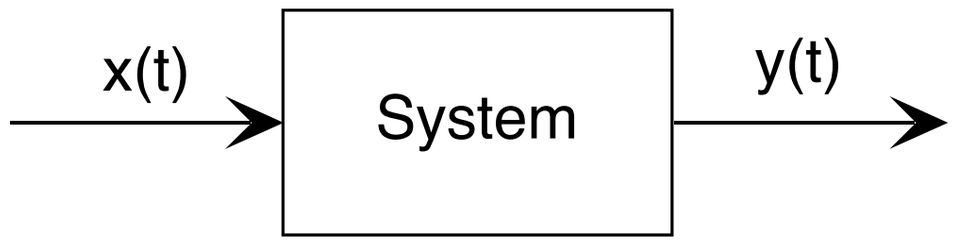
Fundamentals of Electrical Engineering

Basics of Systems

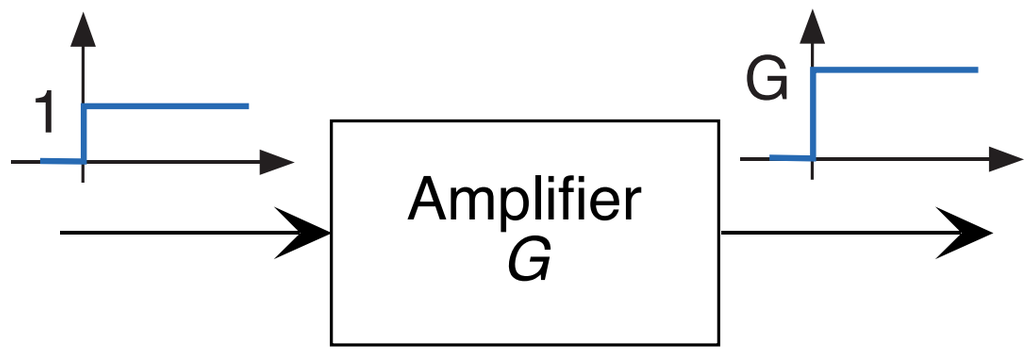
- Simple systems
- System structures
- Linear systems

RICE

Simple Systems



Gain $\quad y(t) = G \cdot x(t)$



$G > 1$ amplifier

$G < 1$ attenuator

$G < 0$ inverter

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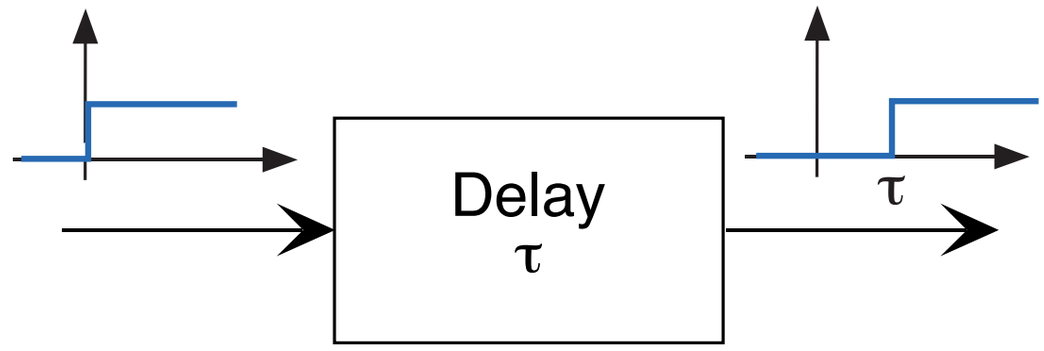
Simple Systems

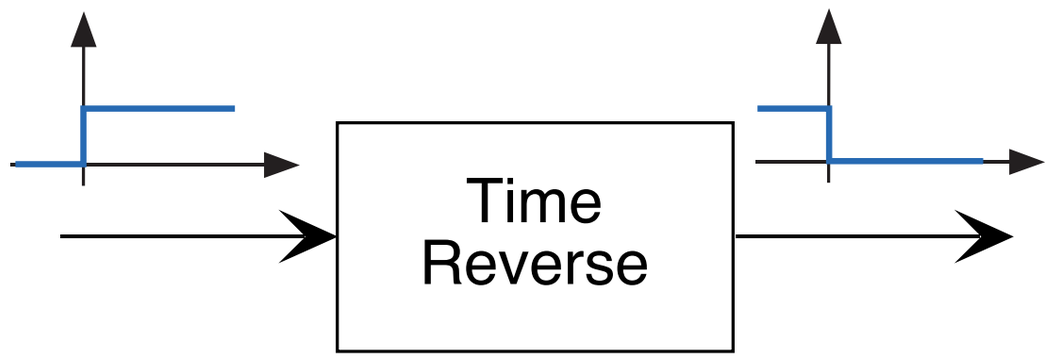
Time delay $y(t) = x(t - \tau)$



$\tau > 0$ time delay

$\tau < 0$ time advance

Time reversal $y(t) = x(-t)$



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Simple Systems

Derivative $$y(t) = \frac{d\,x(t)}{dt}$$

Integrator $$y(t) = \int_{-\infty}^{t} x(\alpha)\,d\alpha$$

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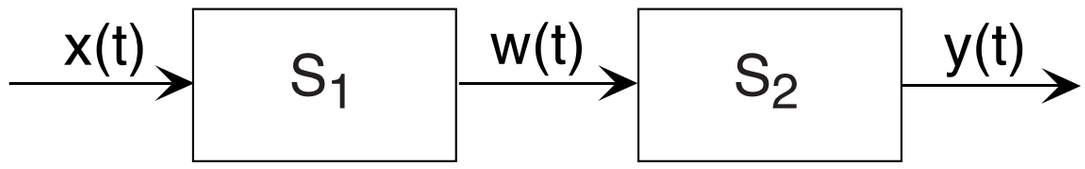
System Structures

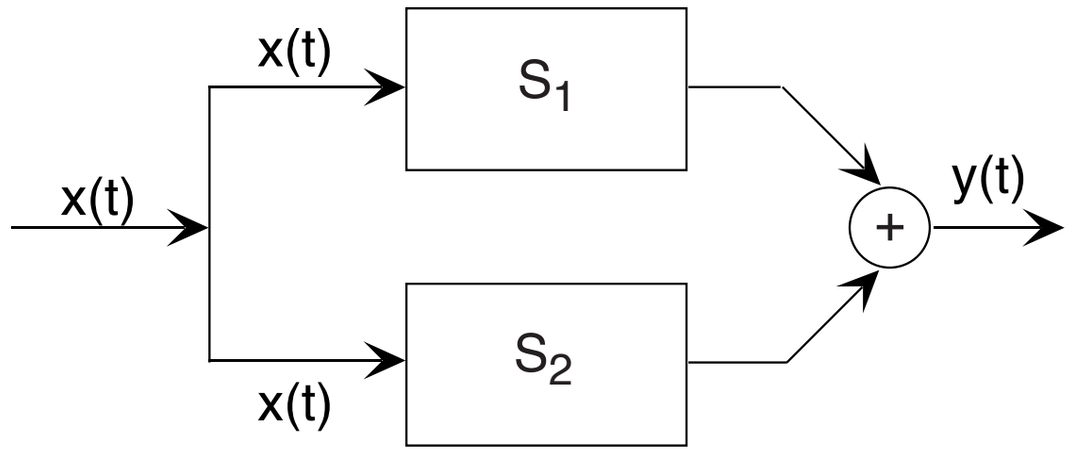
Cascade

$$y(t) = S_2[w(t)] = S_2\left[S_1[x(t)]\right]$$



Parallel

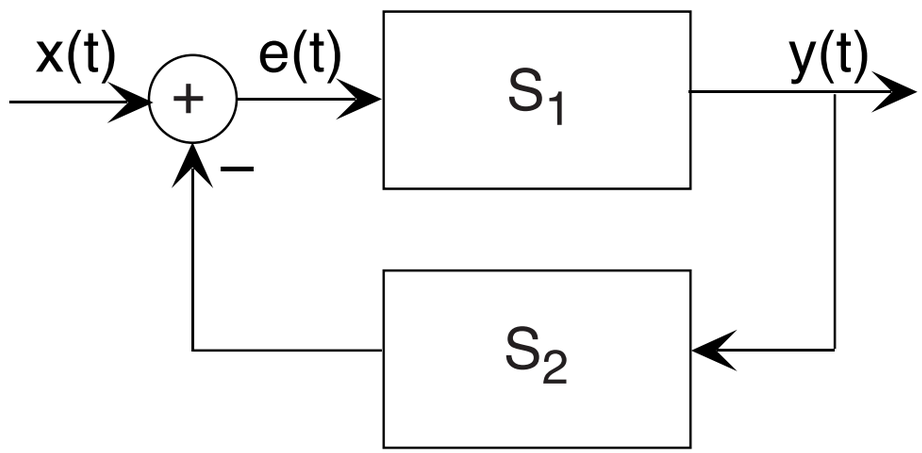
$$y(t) = S_1[x(t)] + S_2[x(t)]$$



Feedback

$$y(t) = S_1[e(t)]$$

$$e(t) = x(t) - S_2[y(t)]$$

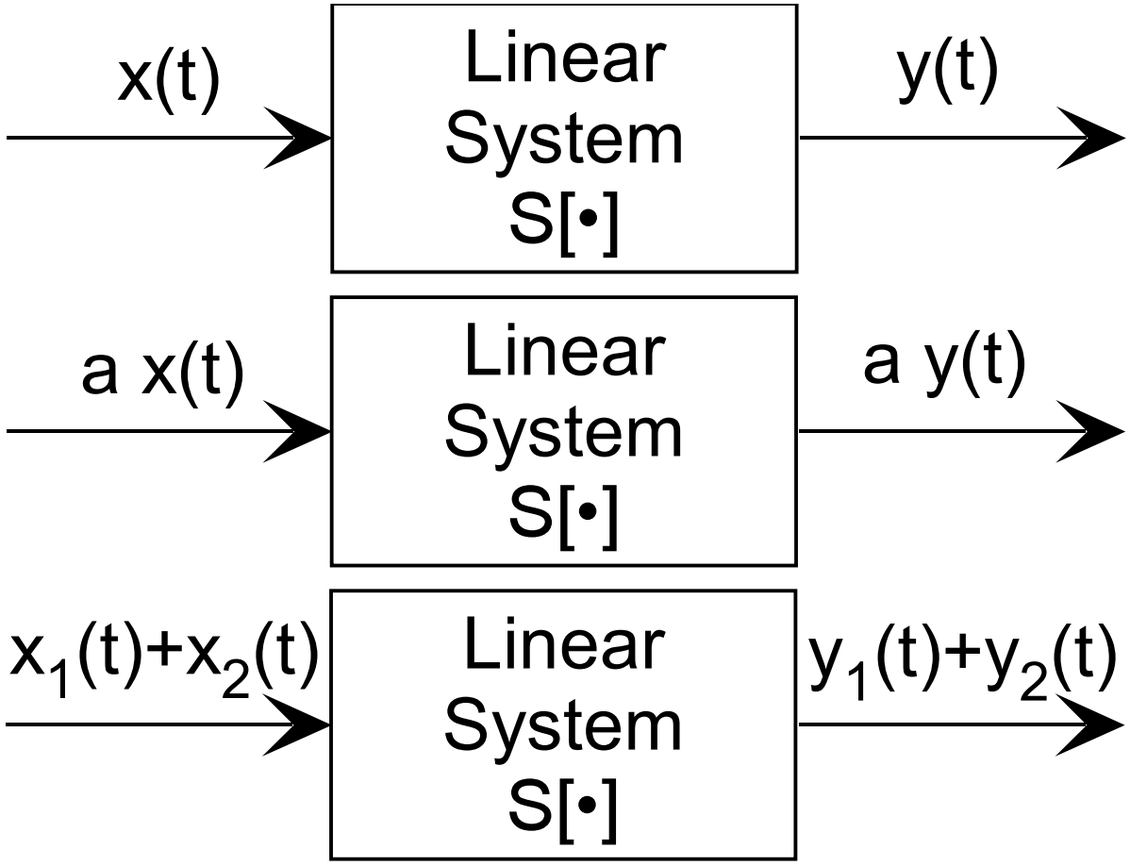


Special Systems

Linear Systems

Principle of Superposition

$$S[a_1 x_1(t) + a_2 x_2(t)] = a_1 S[x_1(t)] + a_2 S[x_2(t)]$$



Special case: $a_2 = -a_1,\ x_1(t) = x_2(t) \triangleq x(t)$

$$S[a_1 x(t) - a_1 x(t)] = S[0] = a_1 S[x(t)] - a_1 S[x(t)] = 0$$

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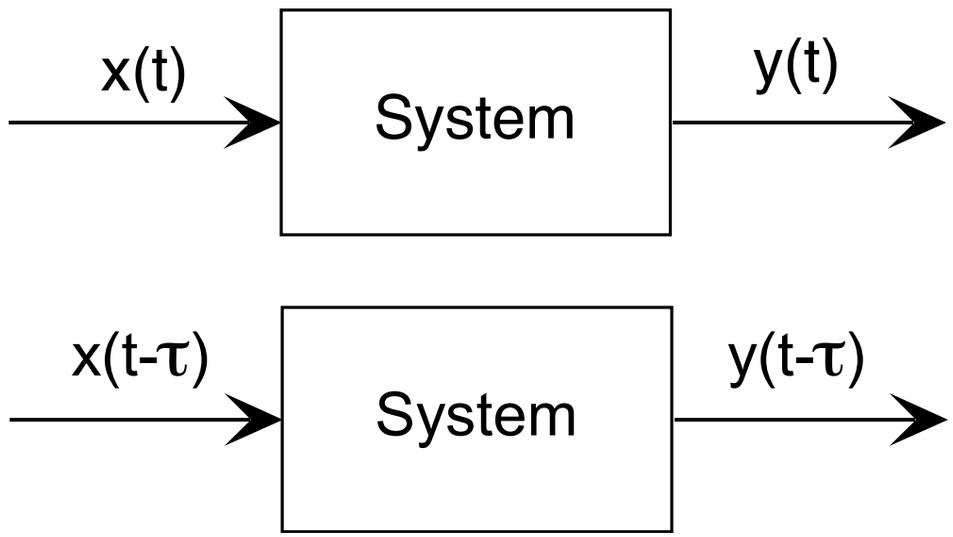
Special Systems

Time-Invariant Systems



	TI?	Linear?
$y(t) = G \cdot x(t)$	✔	✔
$y(t) = \frac{d\,x(t)}{dt}$	✔	✔
$y(t) = x^2(t)$	✔	✘
$y(t) = x(t) \cdot \cos 2\pi f_c t$	✘	✔

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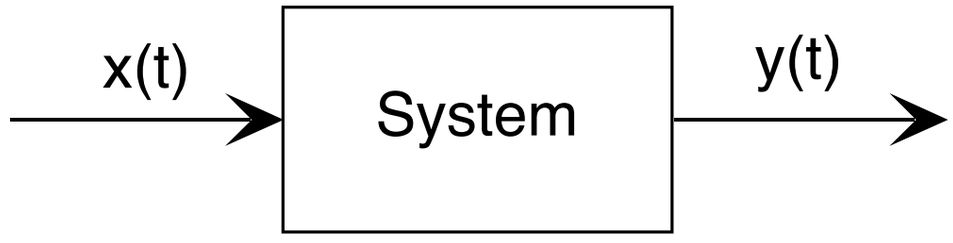
Systems



- Systems operate on an input signal to produce an output signal signal
- Provide gain, delay in time, integrate,…
- Linear, time-invariant systems are *very* important

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